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CENTRAL INTELLIGENCE AGENCY

C-O-N-F-I-D-E-N-T-I-A-L

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SOURCE EVALUATIONS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

[redacted]

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1. [redacted]

2. The report deals with the Prague-Kolin sector of the Prague-Kosice railroad line, the Havlickuv Brod - Brno railroad line, the reconstruction of the Havlickuv Brod - Roustany - Pohled-Pribyslav-Mesto Zdar highway, and the reconstruction of the Havlickuv Brod-Bartovsov-Dlouha Ves-Pribyslav highway. There is also a supplement dealing with a lecture given by Prof. Frantisek Jansa of the College of Railroad Engineering in Prague on 15 May 1956 on the subject of the electrification of the Czechoslovak railroads.

[redacted]

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RAILROADS AND HIGHWAYS IN CZECHOSLOVAKIA (C)

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RAILROADS AND HIGHWAYS IN CZECHOSLOVAKIA (C)

Introduction

This report contains information on two railroads and two highways in Czechoslovakia which were recently reconstructed.

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Listed below are the names and geographic and UTM coordinates of locations used throughout this report. Coordinates are not shown for well-known locations.

Location	Geographic Coordinates	UTM Coordinates
BARTOVSOV	N49-35, E15-39	XR-8572
BOHOMIN	N49-55, E18-20	CA-0933
BRZKOV	N49-32, E15-44	WQ-5386
CESKA TREBOVA	N49-54, E16-27	XR-0429
CESKY SICNDORF	N49-36, E15-42	WQ-5095
CHOCEN	N50-00, E16-40	WR-8754
DLOUHA VES	N49-40, E15-36	WQ-4892
DVOREK	N49-34, E15-41	WQ-5291
HAVLICKUV BROD	N49-37, E15-35	WQ-5295
HESOV	N49-35, E15-43	WQ-5292
HUMPOLEC	N49-33, E15-22	WQ-2688
KYNZVART	N50-01, E12-36	UR-2942
MESTO ZDAR	N49-34, E15-57	WQ-6891
NOVE DVORY	N49-34, E15-48	WQ-5991
NYMBURK	N50-11, E15-03	WR-0360
OLESNA	N49-33, E15-46	WQ-5589
POHLED	N49-36, E15-39	WQ-4795
POHLEDSTI DVORACI	N49-37, E15-37	WQ-4397
PRIBYSLAV	N49-35, E15-44	WR-8381
RONOV	N49-34, E15-46	WQ-5591
ROSICKA (ROSICE)	N49-32, E15-51	WQ-6288
ROUSTANY	N49-37, E15-39	WQ-4697
RUZOMBEROK	N49-05, E19-19	CV-7738
SAZAVA	N49-34, E15-51	WQ-6290

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[redacted] 50X1-HUM

Location	Geographic Coordinates	UTM Coordinates
SLAPY	N49-48, E14-22	VR-5618
STECHOVICE	N49-51, E14-24	VR-5822
TISNOV	N49-21, E16-26	VR-2501
TREBIC	N49-18, E15-53	WQ-6452
UTIN	N49-35, E15-42	WQ-5094

A. TWO RAILROAD LINES IN CZECHOSLOVAKIA

1. PRAGUE-KOLIN Sector of the PRAGUE-KOSICE Railroad Line

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a. History

[redacted] Because Czechoslovakia's two main railroad routes (PRAGUE-KOSICE to the USSR border and PRAGUE-BRNO-BRATISLAVA to the Austrian border) used this line, it was the most traveled line in Czechoslovakia.

It became necessary to lay a third track, because the line had become so overburdened it was almost impossible to run passenger trains on schedule. Trains were often 40 minutes late, and delays of 1 to 3 hours were not unusual. Construction of the third track was started in 1952. It was begun at PRAGUE and the sections were put into operation as soon as they were completed. [redacted] 50X1-HUM [redacted] the third track from PRAGUE to KOLIN was in operation. In some places the track was constructed on the widened roadbed of the former double-track line and in others on a separate roadbed 20 m from and parallel to the former line. Frequently, trains [redacted] switched from one track 50X1-HUM to another.

b. Permanent Ways

[redacted] the rails used on this line were known as "Chinese" [redacted] rails. They had been ordered by these governments, 50X1-HUM but had been rejected because they did not satisfy their requirements. [redacted] 50X1-HUM these rails weighed approximately 50 kg per meter. The roadbed was of crushed rock. The rails were laid on wooden ties; [redacted] 50X1-HUM there were no weight restrictions on this line. [redacted] steam locomotives pulling as many as 60 fully-loaded, two-axle freight cars.

c. Signal System

[redacted] this line had a fully automatic signal system con- 50X1-HUM sisting of electric target lights: green indicating open, yellow indicating caution, and red indicating stop. On open tracks the signals were installed approximately every 400 m.

d. Electrification [1].

The electrification of the PRAGUE-KOLIN-KOSICE line was started in 1952, 50X1-HUM and electrical operation began on a limited scale in the PRAGUE-KOLIN sector [redacted]

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[redacted] 50X1-HUM

[redacted] some work had been done on the KOLIN-KOSICE sector [redacted] saw trains drawn by electric engines going east out of KOLIN. 50X1-HUM

Power distribution was by overhead cable. Electric power was supplied from the national grid. Because of the electric power shortage in Czechoslovakia (before 1952 civilian electricity consumption was curtailed in PRAGUE for several hours each evening during the winter months), it was necessary to construct three hydroelectric power stations on the Vltava River for the electrification of this line. [redacted] the location of [redacted] two of these stations: one was at STECHOVICE and one at SLAPY. [redacted] saw three or more transformer stations [redacted] and one mobile transformer unit on this line. The latter consisted of approximately 20 cars; [redacted] 50X1-HUM

e. Railroad Engines

(1) Electric Engines [1].

The electric engines used on this line were manufactured at the Lenin (Skoda) works in PILSEN. [redacted] the type of engine used was the E499. [redacted] the ratio of steam locomotives to electric engines was 10:1. 50X1-HUM

(2) Freight Steam Locomotives

The freight steam locomotive models 555 and 556 had been in use since WW II. [redacted] all locomotives, including models 555, 556, and 498, were manufactured in Poland from Czechoslovak plans. Before the Communists took over in Czechoslovakia, locomotives and railroad cars had signs on them indicating where they were manufactured; these have since disappeared. 50X1-HUM

[redacted] the meaning of locomotive model numbers [redacted] The first digit indicated the number of drive axles; thus, model 555 had five drive axles. To the second digit one added 3 and multiplied by 10, thereby arriving at the locomotive's maximum speed; model 555's maximum speed was 80 km per hour. By placing a 1 in front of the last digit one arrived at the locomotive's maximum tonnage per axle; model 555 had a maximum of 15 tons per axle. [redacted] 50X1-HUM 50X1-HUM

(3) Passenger Locomotives

The only passenger locomotive models [redacted] used in Czechoslovakia were the 498 and 375. [redacted] the 498 was introduced sometime after 1945. [redacted] saw these locomotives at the KOLIN roundhouse; usually, there were 18 to 20 locomotives standing in the service area. [redacted] first saw the model 375 in use on the PRAGUE-KOLIN line in 1947 or 1948. 50X1-HUM

(4) Fuel

Poor quality coal was used for the operation of locomotives, which were not able to attain their maximum speed. Also, until February 1958 locomotive engineers received premiums for economical coal consumption. The result was that the trains usually ran from 30 minutes to 3 hours late. After this premium system was abolished and the Ministry of Railroads was reorganized, the train schedules were more closely followed.

[redacted] 50X1-HUM

f. Rolling Stock

(1) Passenger Cars

Since 1952 almost all national and international trains in Czechoslovakia have consisted of four-axle steel coaches. Most of these trains had baggage and/or mail cars and some had buffet or dining cars. The national express had from 8 to 12 coaches and the international had from 16 to 20. Local trains were still made up of the old-style wooden coaches.

(2) Freight Cars

Old-style, double-axle wooden cars were used. They were approximately 10 to 15 m long and had a capacity of 20 tons. There were two types: the low-side gondolas and box cars with center sliding doors. Every second or third car had an end cabin and cupola for the brakeman. On each train only two or three of these cupolas were occupied by brakemen; the end cabin of the last car was usally occupied. A freight train usually consisted of from 50 to 60 cars.

g. Traffic

An express train traveled the PRAGUE-KOLIN sector in 1 hour. There were no stops between PRAGUE and KOLIN. All trains making this run were overcrowded. In order to get a seat one had to board the train in PRAGUE 1 hour before starting time.

h. Installations en Route

(1) Bridges and Culverts

This line passed over only a few short bridges. [redacted] 50X1-HUM one bridge, located less than halfway along the line as one came from PRAGUE, which was widened from approximately 9 m to approximately 12 m when the third track was laid [redacted] This line also passed over 50X1-HUM several culverts which spanned narrow water courses. [redacted]

(2) KOLIN Railroad Yard (For location see Annex A; for sketch see Annex B.)

[redacted] 50X1-HUM This yard was on the main line PRAGUE-KOLIN-PARDUBICE-CHOCEN-CESKA TREBOVA-OLOMOUC-OSTRAVA-BOHOMIN-ZILINA-RUZOMBEROK-KOSICE. It was constructed in 1938. From 1952 to 1958, the passenger station section was electrified. At the same time the marshaling yard and the locomotive service facilities were enlarged to enable them to handle the increased freight traffic. The yard was approximately 1,100 m long.

The passenger station section (see Annex B) was about 300 x 60 m. It had four through tracks and six to eight sidings. Three of the main tracks (Item 1, Annex B) running westward from the station to PRAGUE were electrified. The fourth track (Item 2, Annex B) ran to NYMBURK. Two of the main tracks (Item 3, Annex B) running east from the station to CESKA TREBOVA were electrified. The other two tracks (Item 4, Annex B) ran to HAVLICKUV BROD. The sidings were used for transient freight trains and for loading passengers. [redacted] 50X1-HUM

[redacted] 50X1-HUM

[redacted] There were four or five concrete platforms covered with roofs (Item 5, Annex B) for loading passengers. [redacted] only one switching tower (Item 6, Annex B) which was located in the northwest corner of the passenger station section. The passenger station building (Item 7, Annex B) had two or three stories and was about 30 x 20 x 10 m. 50X1-HUM 50X1-HUM

The freight yard was about 800 m long [redacted]. The freight classifying was accomplished by the hump arrangement (Item 10, Annex B); [redacted] Within the locomotive servicing area there were two turntables and two roundhouses (Item 8, Annex B), two locomotive repair shops (Item 9, Annex B), coaling stations, and water towers. [redacted] There were usually 18 to 20 locomotives standing on the sidings adjacent to the locomotive servicing facilities. 50X1-HUM 50X1-HUM 50X1-HUM

2. HAVLICKUV BROD-BRNO Railroad Lines (See Annexes C and D.)

a. History

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In 1936, a second track was added to the single track standard-gauge KOLIN-HAVLICKUV BROD-JIHLAVA-TREBIC-BRNO line (for location see Item 2, Annexes C and D). At that time it was decided that even with the addition of this second track the line would be overburdened, and plans for a new double-track HAVLICKUV BROD-POHLED-PRIBYSLAV-NOVE DVORY-SAZAVA-MESTO ZDAR-TISNOV-BRNO line (for location see Item 1, Annexes C and D) were drawn. The existing single track standard-gauge HAVLICKUV BROD-POHLED-PRIBYSLAV-SAZAVA-MESTO ZDAR line, which was constructed at the turn of the century [redacted] had become unsuitable for modern traffic because of its weak roadbed and poor alignment. When the new line was put into operation in 1958, only a few local sections (one of which was the NOVE DVORY-MESTO ZDAR sector) of this old single-track line remained in use.

Construction of the new HAVLICKUV BROD-POHLED-PRIBYSLAV-NOVE DVORY-SAZAVA-MESTO ZDAR-TISNOV-BRNO line started in 1936. At that time work was begun on a bridge (for location see Annex E, Item 2) and tunnel (for location see Annex E, Item 3) east of the HAVLICKUV BROD railroad yard and on the roadbed in several unrecalled places. Before a great deal had been accomplished, the project was interrupted by the outbreak of WW II. In 1946, construction was resumed. By 1956, an 8-meter-wide roadbed with a single track was completed and the line was opened to limited traffic. The laying of the second track proceeded very slowly until the fall of 1957. Apparently at that time high priority was given to the completion of this project, for in the winter of 1957/1958 civilian laborers aided by soldiers [redacted] finished laying the entire second track between HAVLICKUV BROD and BRNO. By May 1958, scheduled express trains bearing signs which read "BROD-ZDAR-TISNOV-BRNO" ran on this line. 50X1-HUM

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[redacted] the HAVLICKUV BROD-PRIBYSLAV sector [redacted] This sector was 14.5 km long. [redacted]

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[redacted]

b. Permanent Ways

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[redacted] the rails used in the construction of this line's tracks were "Chinese" [redacted] rejects and [redacted] their weight was approximately 50 kg per meter. The ties were wooden and impregnated at a factory in ROSICKA (ROSICE). [redacted] had not seen any concrete or steel ties on this line. The rails were fastened to the ties with nuts and bolts. 50X1-HUM

50X1-HUM

Local crushed granite was used for the roadbed. [redacted], because of an inaccurate geological study of the rocks forming the retaining walls of the through cuts on this line (for location see Annex F, Item 4), the walls had been made too steep and the brittle character of their rocks caused frequent landslides onto the tracks; as a result, they had to be bound with concrete at a great increase in construction cost. There were no grade crossings on the HAVLICKUV BROD-NOVE DVORY sector of this line, and [redacted] there were none as far as MESTO ZDAR. 50X1-HUM

There were no weight restrictions on this line. [redacted] 1,000-ton freight trains were being brought over it even in 1957, when it was still operating as a single-track line. Usually, one steam locomotive, model 555 or 556, pulled these 1,000-ton trains. [redacted] delay was that a freight train had been unable to make the gradient between NOVE DVORY and SAZAVA and had had to back up to NOVE DVORY, from which, after the train was divided into two sections, a locomotive pulled each section separately to SAZAVA. After the second track was put into operation, there were no unusual delays. 50X1-HUM 50X1-HUM

c. Signal System

[redacted] saw semaphores beside each track at both ends of every station. [redacted]

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d. Railroad Locomotives

[redacted] saw freight steam locomotive models 555, 556, and 354, and passenger steam locomotive models 498 and 375 used on this line. 50X1-HUM

[redacted] the train stations at POHLEDSTI DVORACI, CESKY SICNDORF (STRIBRNE HORY), HESOV, RONOV, and NOVE DVORY were still unfinished. They had no station buildings or servicing and repair facilities. [redacted] locomotives were dispatched to HAVLICKUV BROD for servicing from points east of NOVE DVORY, a distance of 30 km or more. 50X1-HUM 50X1-HUM

A coal point was located at HAVLICKUV BROD and possibly one at MESTO ZDAR.

e. Rolling Stock

All the types of rolling stock used on the PRAGUE-KOLIN line were seen [redacted] on this line. In addition, [redacted] four-axle steel tank cars with single domes; possibly these were used to transport diesel oil to PRAGUE. 50X1-HUM

f. Traffic

[redacted] seven passenger trains stopped each day at PRIBYSLAV on the run from BRNO to HAVLICKUV BROD. These trains stopped at 0400, 0600, 1000, 1300, 1500, 1800, and 1900 hours. [redacted] in addition to these, two express 50X1-HUM

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[redacted] 50X1-HUM

trains passed through PRIBYSLAV each day from BRNO on the way to HAVLICKUV BROD. [redacted] these two did not stop at PRIBYSLAV. [redacted] 120 trains passed through this station each day. 50X1-HUM

The maximum traveling speed for all trains, including express trains, on this line was 35 km per hour. [redacted] 50X1-HUM

g. Installations in the HAVLICKUV BROD-NOVE DVORY Sector (See Annex E.)

(1) HAVLICKUV BROD Railroad Yard (For location see Annex E, Item 1; for sketch and description see Annex G.)

There were three main tracks running through this station northwest to southeast, and one running north. Two of those running northwest went to PRAGUE and one to HUMPOLEC. Two of those running southeast went to MESTO ZDAR and one to JIHLAVA. The track running north led to PARDUBICE. None of these tracks was covered and there were no safety underpasses.

The freight loading section (see Annex G, Item 1) was approximately 800 m long and 60 m wide. It had two or three sidings (Annex G, Item 2); [redacted] 50X1-HUM The freight shed (Item 3, Annex G) was flat-roofed, constructed of wood and approximately 30 x 15 x 5 m. In front of the freight shed was a loading platform from which side loading was accomplished. [redacted] saw a stucco-covered brick structure (Item 4, Annex G), approximately 20 x 20 x 12 to 15 m, which was 5 stories high and had a low gabled roof; he believed this was a grain silo. 50X1-HUM

The running tracks within the passenger section (Item 5, Annex G) were approximately 250 to 300 m long. The passenger station building (Item 6, Annex G) was 80 x 40 x 10 m and built of brick covered with stucco. It was a two-storied building and contained the ticket office, waiting rooms, baggage rooms, and restaurants. The stationmaster and dispatch building (Item 7, Annex G) was two-storied, of brick, and approximately 15 x 10 x 8 m. [redacted] The station post office (Item 8, Annex G) was a two-storied, gable-roofed building, approximately 12 x 10 x 8 m, constructed of brick covered with stucco. 50X1-HUM

There were three shunting tracks (Item 10, Annex G) in the locomotive servicing section (Item 9, Annex G) of this yard. These were used for shunting locomotives and passenger cars; [redacted] The locomotive repair shop (Item 11, Annex G) was a sheet-metal-roofed brick building, approximately 40 x 20 x 10 m. There were four tracks running into this shop, and [redacted] there was enough track inside the shop for eight locomotives. The diameter of the turntable (Item 12, Annex G) was 25 m. It was capable of holding locomotive models 556 and 498 with their tenders. There was one coaling station (Item 13, Annex G) with a crane dispenser and two water towers (location unrecalled). [redacted] saw passenger steam locomotive models 555, 556, 354, and freight steam locomotive model 498 at this station. [redacted] saw locomotive models 310 and 422, which were used for shunting. 50X1-HUM 50X1-HUM 50X1-HUM 50X1-HUM

(2) Railroad Bridge (For location see Annex E, Item 2; for sketch see Annex H).)

This was a single-span, steel, deck-type, lattice-girder railroad bridge. The span was approximately 12 m long. The abutments were of stone faced with concrete and were approximately 1.5 m thick at their bases. The bridge was

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[redacted]

approximately 9 m wide, the railway was approximately 8 m wide, and the walks were each approximately .50 m wide. There was a one-meter-high railing on each side.

This bridge spanned a tributary of the Sazava River which was 4 to 5 m wide and less than 1 m deep. Throughout the year the average clearance under the bridge was approximately 4.5 m. There were no floods or high water seasons in this area of the Sazava River. Usually during January and February this river and its tributaries were frozen solid and covered with .8 to 1.2 m of snow.

(3) HAVLICKUV BROD Railway Tunnel (For location see Annex E, Item 3.)

Construction of this tunnel was started before WW II; it was completed and opened to traffic in 1955 or 1956. It was approximately 1 km long and approximately 10 m wide; the railway was approximately 8 m wide and the walks 1 m wide each. The tunnel was of concrete arch construction; it was built through a hill approximately 100 m high. The tunnel was just high enough to clear a locomotive's smoke stack; [redacted] 50X1-HUM

Approximately 120 trains passed through this tunnel every 24 hours. Local climatic conditions did not interfere with traffic. [redacted] if for any reason the tunnel were closed off, the old single-track line which circumvented the hill would be used. At a point approximately 2.5 km northeast of the HAVLICKUV BROD railroad station and 100 m east of POHLEDSTI DVORACI, this old line left its parallel course to the new line and continued around the northern side of the hill. 50X1-HUM

(4) Fill (For location see Annex E, Item 4.)

This fill was approximately 2 m high and 350 m long. The surrounding terrain was the low marshland of the Sazava River.

(5) Railway Bridge (For location see Annex E, Item 5.)

This was a deck-type, concrete-arch railway bridge. Its span was approximately 12 m long and 9 m wide; the railway was approximately 8 m wide, and the walks were each approximately .50 m wide.

This bridge spanned a tributary of the Sazava River which was approximately 4 to 5 m wide and less than 1 m deep. Clearance under the bridge was approximately 2 m.

(6) Fill (For location see Annex E, Item 6.)

This fill was approximately 2 m high and 700 m long. The surrounding terrain was the low marshland of the Sazava River.

(7) POHLEDSTI DVORACI Railroad Stop (For location see Annex E, Item 7.)

Only local trains stopped here. The station was approximately 200 m long. There were no sidings, station buildings, freight loading facilities, or railroad personnel at this station. The train conductors were responsible for entraining and detraining passengers.

(8) Through Cut (For location see Annex E, Item 8.)

This through cut was approximately 15 to 20 m deep and 1800 m long. Its sides were steep and sown with grass.

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[redacted] 50X1-HUM

(9) Railroad Bridge (For location see Annex E, Item 9; for sketch see Annex H.)

This was a single-span, deck-type, lattice-girder railway bridge. Its span was approximately 16 m long. The abutments were of concrete-covered stone and were approximately 1.5 m thick at their bases. The bridge was approximately 9 m wide; the railway was approximately 8 m wide; and the walks were each approximately .50 m wide. There was a 1-meter-high railing on each side.

This bridge spanned a tributary of the Sazava River which was 4 to 5 m wide and less than 1 m deep. The clearance under the bridge was 4.5 m.

(10) Embankment (For location see Annex E, Item 10.)

This embankment was 3 to 4 m high and several kilometers long. The surrounding terrain was the low marshland of the Sazava River valley.

(11) POHLED Railroad Station (For location see Annex E, Item 11; for sketch see Annex I.)

This yard was approximately 250 to 300 m long and 25 m wide. It was constructed on a two-meter-high fill. It had two main tracks (see Item 1, Annex I) and three sidings. Two of the sidings (Item 2, Annex I) were used for transient freight traffic and the third (Item 3, Annex I) for loading freight trains. There was a brick warehouse (Item 4, Annex I), approximately 45 x 9 x 4 m, which had a low gabled roof. In front of the warehouse was a platform from which side loading was accomplished. There was also a temporary stationmaster's office (Item 5, Annex I). Excavation work for the construction of the station building (Item 6, Annex I) was under way [redacted] At that time there were no facilities for passengers at this station; [redacted] passengers bought their tickets on the train. 50X1-HUM

(12) Highway Overpass (For location see Annex E, Item 12.)

The POHLED-DLOUHA VES highway passed over the railway at this point. The overpass was approximately 6 m wide, 4 m high, and constructed of concrete.

(13) Through Cut (For location see Annex E, Item 13.)

This through cut was approximately 6 m deep and 2 km long. There was also a gradient on this section. On the northern side of the through cut there was an abandoned stone quarry; possibly this was used during the construction of this line.

(14) Highway Overpass (For location see Annex E, Item 14.)

A local road, CESKY SICNDORF-UTIN, passed over the railway at this location. The overpass was approximately 5 m wide, 4 m high, and constructed of concrete.

(15) CESKY SICNDORF Railroad Stop (For location see Annex F, Item 1.)

Only local trains stopped here. The station was approximately 200 m long. There were no sidings, station buildings, freight loading facilities, or railroad personnel at this station. The train conductors were responsible for entraining and detraining passengers.

(16) Through Cut (For location see Annex F, Item 2.)

This through cut was approximately 6 m deep and 1.5 km long. The sides of the through cut were sown with grass. The surrounding terrain was forested.

(17) Railroad Bridge (For location see Annex F, Item 3.)

This was a single-span, steel, deck-type, lattice-girder railroad bridge. The span was approximately 14 m long. The abutments were of stone covered with concrete and were approximately 1.5 m thick at their bases. The bridge was approximately 9 m wide; the railway was approximately 8 m wide; and the walks were each approximately .50 m wide.

This bridge spanned a tributary of the Sazava River which was 4 to 5 m wide and less than 1 m deep. Throughout the year the average clearance under the bridge was 4.5 m.

(18) Through Cut (For location see Annex F, Item 4.)

This through cut was approximately 6 m deep and 1.5 km long.

(19) HESOV Railroad Stop (For location see Annex F, Item 5.)

Only local trains stopped here. The station was approximately 200 m long. There were no sidings, station buildings, freight loading facilities, or railroad personnel at this station. The train conductors were responsible for entraining and detraining passengers.

(20) Fill (For location see Annex J, Item 1.)

This fill extended from the HESOV railroad stop (Item 5, Annex F) to the highway overpass (Item 5, Annex J). Its height varied from 2 to 5 m.

(21) Railroad Overpass (For location see Annex J, Item 2.)

This was a single-span, reinforced concrete-slab overpass resting on concrete abutments. It was approximately 8 m long and 9 m wide; the railway was approximately 8 m wide; and the walks were each approximately .50 m wide. The railway passed over the PRIBYSLAV-HESOV highway at this location.

(22) Railroad Overpass (For location see Annex J, Item 3.)

This was a single-span, steel deck-type, lattice-girder railway overpass. At this point the railway passed over the PRIBYSLAV-DVOREK highway. It was approximately 8 m long and 9 m wide; the railway was approximately 8 m wide; and the walks were each approximately .50 m wide. The span rested on abutments of stone covered with concrete, which were approximately 1.5 m thick at their bases. The clearance under the overpass was approximately 5.5 m.

(23) Through Cut (For location see Annex J, Item 4.)

This through cut was approximately 10 m deep. When it was first constructed its walls were of granite; later they began to crack and rocks frequently fell onto the roadbed.. Because of this, the walls were later bound with cement.

(24) Highway Overpass (For location see Annex J, Item 5.)

This was a single-span, deck-type, reinforced concrete, closed-spandrel-arch overpass. It was approximately 8 m long and 9 m wide; the railroad was approximately 8 m wide; and the walks were each approximately .50 m wide. The clearance under the overpass was approximately 4.5 m. The railway passed under the PRIBYSLAV-BRZKOV highway at this point.

(25) Railroad Bridge (For location see Annex J, Item 6; for sketch see Annex H.)

This was a single-span, steel deck-type, lattice-girder railway bridge. Its span was approximately 14 m long. The abutments were of stone covered with concrete and were approximately 1.5 m thick at their bases. The bridge was approximately 9 m wide; the railway was approximately 8 m wide; and the walks were each approximately .50 m wide. There was a 1-meter-high railing on each side.

This bridge spanned the Sazava River, which was 4 to 5 m wide and less than 1 m deep. The clearance under the bridge was approximately 6 m.

(26) Steep Grade (For location see Annex J, Item 7.)

This gradient was approximately 1.2 to 1.5 km long.

(27) New PRIBYSLAV Railroad Station (For location see Annex J, Item 8; for sketch see Annex K.)

It was approximately 450 m long and 30 m wide. It had two main tracks (Item 1, Annex K) and three sidings. One of the sidings (Item 2, Annex K) was used for transient freight traffic, one (Item 3, Annex K) for shunting freight or passenger cars, and one (Item 4, Annex K) for shunting only freight cars. In addition to these three, the main track of the old line (Item 5, Annex K) was also used as a siding for freight bound for PRIBYSLAV. There were two open passenger platforms (Items 6 and 7, Annex K), approximately 150 m long by 6 m wide, access to which was gained through an underpass (Item 9, Annex K) whose entrance (Item 8, Annex K) was located on the north side of the station. A wooden shed (Item 10, Annex K), approximately 10 x 4 x 3.5 m, was used as a temporary office for the three or four men employed at this station. Passenger train tickets were still sold at the old line's station building.

(28) Railroad Overpass (For location see Annex J, Item 9; for sketch see Annex H.)

This was a single-span, concrete slab railway overpass resting on reinforced concrete abutments. Here the railway passed over the PRIBYSLAV-OLESNA highway. The overpass was approximately 8 m long and 12 m wide. There were three tracks on it: two main tracks, and one shunting track into the PRIBYSLAV railroad yard.

(29) Through Cut (For location see Annex J, Item 10.)

This through cut was several hundred meters long and approximately 5 m deep.

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(30) Railroad Bridge (For location see Annex J, Item 11; for sketch see Annex H.)

The structure and dimensions of this bridge were the same as those of the bridge described in Paragraph (2) above.

This bridge spanned the Sazava River, which was 4 to 5 m wide and less than 1 m deep. The clearance under the bridge was 12 to 14 m.

(31) Embankment (For location see Annex J, Item 12.)

This embankment was several hundred meters long and approximately 3 m high.

(32) RONOV Railroad Stop (For location see Annex J, Item 13.)

Only local trains stopped here. The station was approximately 200 m long. There were no sidings, station buildings, freight loading facilities, or railroad personnel at this station. The train conductors were responsible for entraining and detraining passengers.

The northern side of this station was located against a hill from which 20 m had been cut. The Sazava River flowed parallel to its southern side.

(33) Railroad Overpass (For location see Annex J, Item 14; for sketch see Annex H.)

This was a single-span, steel deck-type, lattice-girder railroad overpass. Its span was approximately 15 m long. The abutments were of stone covered with cement and were approximately 1.5 m thick at their bases. The bridge was approximately 9 m wide; the railway was approximately 8 m wide; and the walks were each approximately .50 m wide. There was a 1-meter-high railing on each side. Here the railway passed over the RONOV-SAZAVA highway.

(34) Fill (For location see Annex J, Item 15.)

This fill was 2 m high and was surrounded by low marshland.

(35) Fill (For location see Annex J, Item 16.)

This was a low fill. There was also a gradient along this sector.

(36) NOVE DVORY Railroad Station (For location see Annex J, Item 17.)

This station was constructed on an 8- to 10-meter-high fill. In all other respects it was the same as the station described in Paragraph (7) above.

(37) Through Cut (For location see Annex J, Item 18.)

This through cut was approximately 10 m deep and partly surrounded by low marshland. (No construction details recalled.)

(38) Railroad Bridge (For location see Annex L, Item 1.)

This was a deck-type, reinforced concrete arch railway bridge, supported by reinforced concrete piers. It was approximately 400 m long.

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[redacted]

This bridge spanned the Sazava River, which was 4 to 5 m wide and 1 m deep. The clearance under the bridge was approximately 30 m.

(39) MESTO ZDAR Railroad Yard

This yard's dimensions and layout were similar to those of the PRIBYSLAV railroad yard, Paragraph (27). [redacted] This new yard was being built to satisfy the requirements of the local smelting plant, Zdarske Slevarnyzdar, which had been operating since 1947; [redacted]

(40) SAZAVA Railroad Yard

The dimensions and layout of this yard were identical to those of the POHLED railroad yard, Paragraph (11).

B. RECONSTRUCTION OF TWO HIGHWAYS IN CZECHOSLOVAKIA

1. <u>HAVLICKUV BROD-ROUSTANY-POHLED-PRIBYSLAV-MESTO ZDAR Highway</u> (For location see Annex M, Item 1.)

[redacted] it was known as the HAVLICKUV BROD-MESTO ZDAR highway.

a. Construction Details

Until 1956 this was a macadam highway throughout. It was in poor condition and unsuitable for heavy truck traffic. In 1956 it was reconstructed, making it suitable for all types of vehicles. During this reconstruction, the HAVLICKUV BROD-PRIBYSLAV sector was given an asphalt wearing course, and the PRIBYSLAV-MESTO ZDAR sector a new macadam wearing course.

This highway was approximately 33 km long. From HAVLICKUV BROD to ROUSTANY its roadway was 8 m wide; from ROUSTANY to MESTO ZDAR its roadway was 7 m wide. It was constructed on a 1-meter-high fill. From HAVLICKUV BROD to ROUSTANY the wearing course was 6 m wide and from ROUSTANY to MESTO ZDAR it was 5 m wide. There were shoulders 1 m wide of pressed gravel along the entire length of the highway. There were drainage ditches, 1 m wide and .50 m deep, of earth on both sides of the entire highway.

From HAVLICKUV BROD to SAZAVA the surrounding terrain was hill country covered with small forests or farms. From SAZAVA to MESTO ZDAR it was flat and covered with dense forests. There were steep grades at three places (for locations see Annex M, Items 3, 4 and 5). There were sharp curves at two places (for location see Annex M, Items 6 and 7). The maximum safe traveling speed was 40 km per hour.

b. Installations en Route

There were no bridges longer than 3 or 4 m. There was one grade crossing (for location see Annex M, Item 8). There were no overpasses, underpasses, embankments, cuts, or other dangerous road conditions.

[redacted] 50X1-HUM

c. Traffic

This highway was used by all types of vehicles. [redacted] 50X1-HUM approximately 200 vehicles per day traveled this road. This was an all-weather highway.

2. HAVLICKUV BROD-BARTOVSOV-DLOUHA VES-PRIBYSLAV Highway (For location see Annex M, Item 2.)

This highway was primarily of local importance and was known as the HAVLICKUV BROD-BARTOVSOV-PRIBYSLAV highway. [redacted] 50X1-HUM

a. Construction Details

[redacted] 50X1-HUM the road's wearing course, which previously had bad potholes, had been greatly improved. Before that time it had not been possible to travel this road by bus; [redacted] the purpose of the reconstruction was to make the road suitable for bus traffic. [redacted] after the reconstruction it was 50X1-HUM suitable for all types of vehicles.

This highway was 15 km long and had a rolled gravel wearing course approximately 5.5 m wide. [redacted] 50X1-HUM There were drainage ditches on both sides along the entire highway.

The surrounding terrain was flat and covered with coniferous forests. The alignment was poor; there were steep grades at one place (for location see Annex M, Item 9) and sharp curves at two places (for location see Annex M, Items 10 and 11). The maximum safe traveling speed was 40 miles per hour.

b. Installations En Route

There was one bridge on this highway (for location see Annex M, Item 12). This was a single-span, reinforced concrete, deck-type highway bridge, resting on reinforced concrete abutments. Its span was approximately 15 m long. The bridge was approximately 5 m wide, and spanned the Sazava River. No further information.

Within the towns of BARTOVSOV and DLOUHA VES the road narrowed to approximately 3.5 or 4 m; this, coupled with the many sharp curves within these towns, constituted the bottlenecks in this road.

COMMENT:

1. Attached to this report as Annex N is a summary of the text of an address delivered in BUDAPEST by Professor (Dr Ing) Frantisek JANSA on 15 May 1956, to the members of the Hungarian Electrotechnical Association. It is included because it backs up the fragmentary information [redacted] and for its 50X1-HUM own intelligence value.

Annex A

50X1-HUM

PINPOINT LOCATION OF KOLIN RAILROAD IN CZECHOSLOVAKIA

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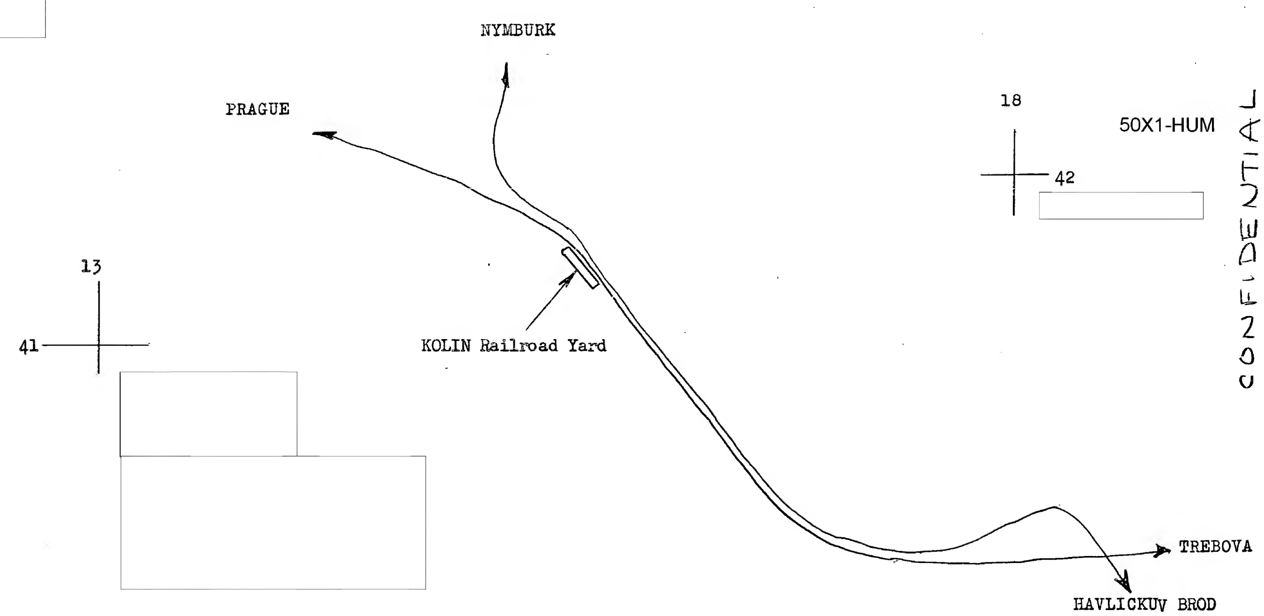

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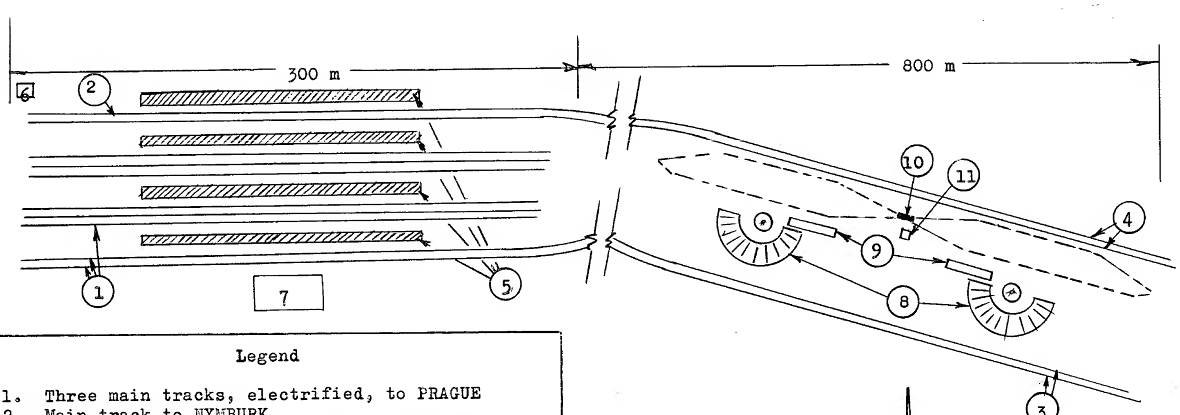
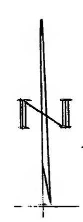
Annex B

50X1-HUM

SKETCH OF KOLIN RAILROAD YARD IN CZECHOSLOVAKIA
(Not to scale)



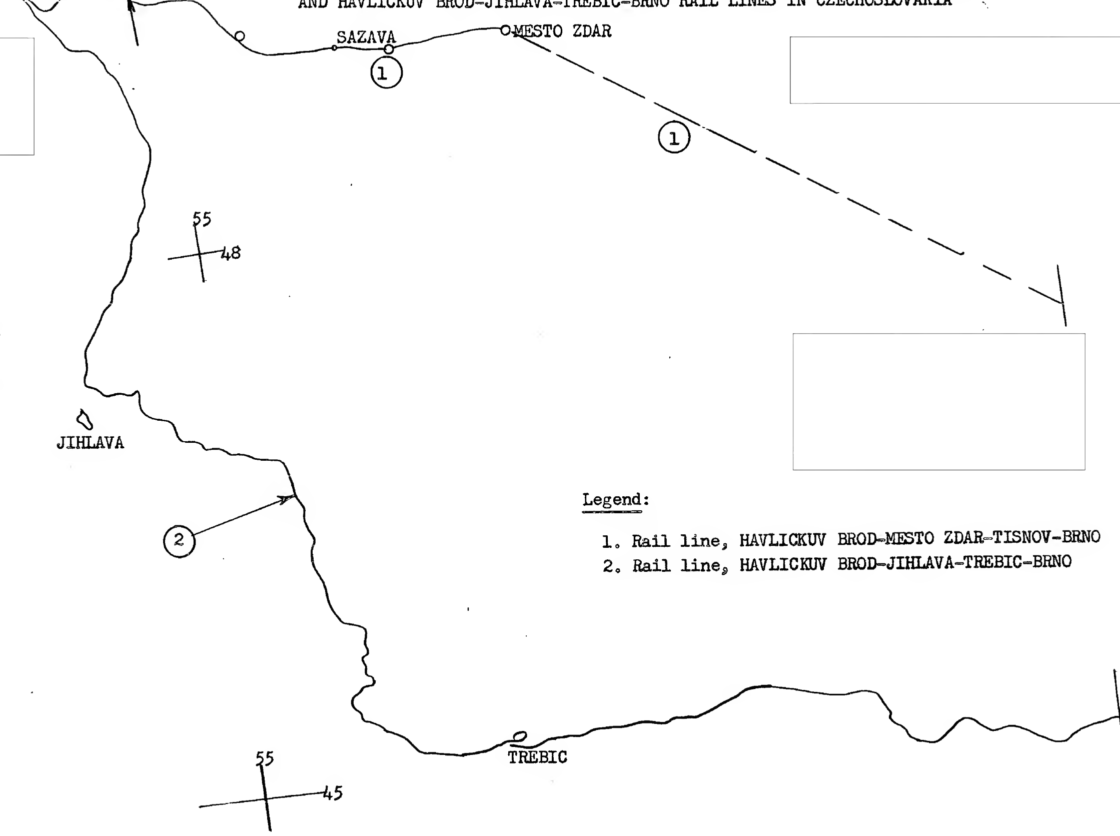


Legend

1. Three main tracks, electrified, to PRAGUE
2. Main track to NYMBURK
3. Two main tracks, electrified, to CESKA-TREBOVA
4. Two main tracks to HAVLICKUV BROD
5. Passenger platforms
6. Switching tower
7. Passenger station building
8. Two turntables and two roundhouses
9. Two locomotive repair shops
10. Hump
11. Control house

Annex C

SKETCH OF ALIGNMENT OF HAVLICKUV BROD-SAZAVA-MESTO ZDAR-TISNOV-BRNO AND HAVLICKUV BROD-JIHLAVA-TREBIC-BRNO RAIL LINES IN CZECHOSLOVAKIA



Annex D

SKETCH OF HAVLICKUV BROD-MESTO ZDAR-TISNOV-BRNO AND HAVLICKUV BROD-JIHLAVA-EBIC-BRNO RAIL LINES IN CZECHOSLOVAKIA

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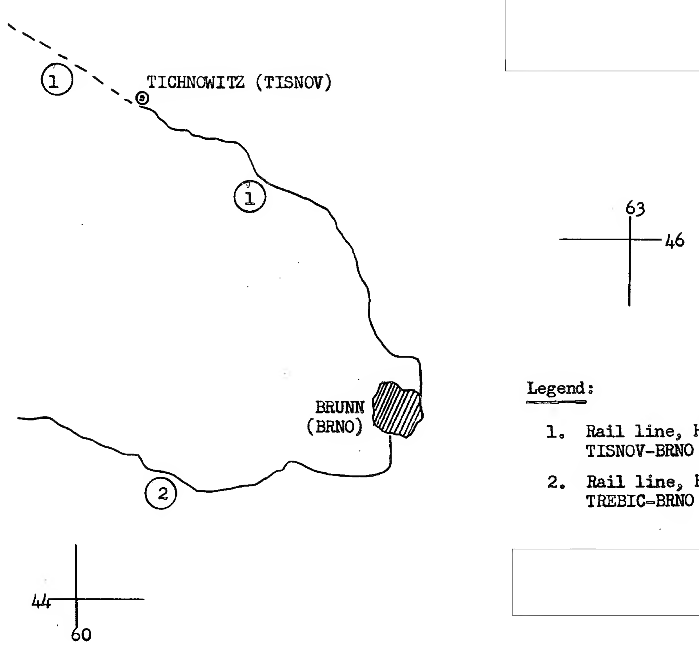

Legend:

1. Rail line, HAVLICKUV BROD-MESTO ZDAR-TISNOV-BRNO
2. Rail line, HAVLICKUV BROD-JIHLAVA-TREBIC-BRNO

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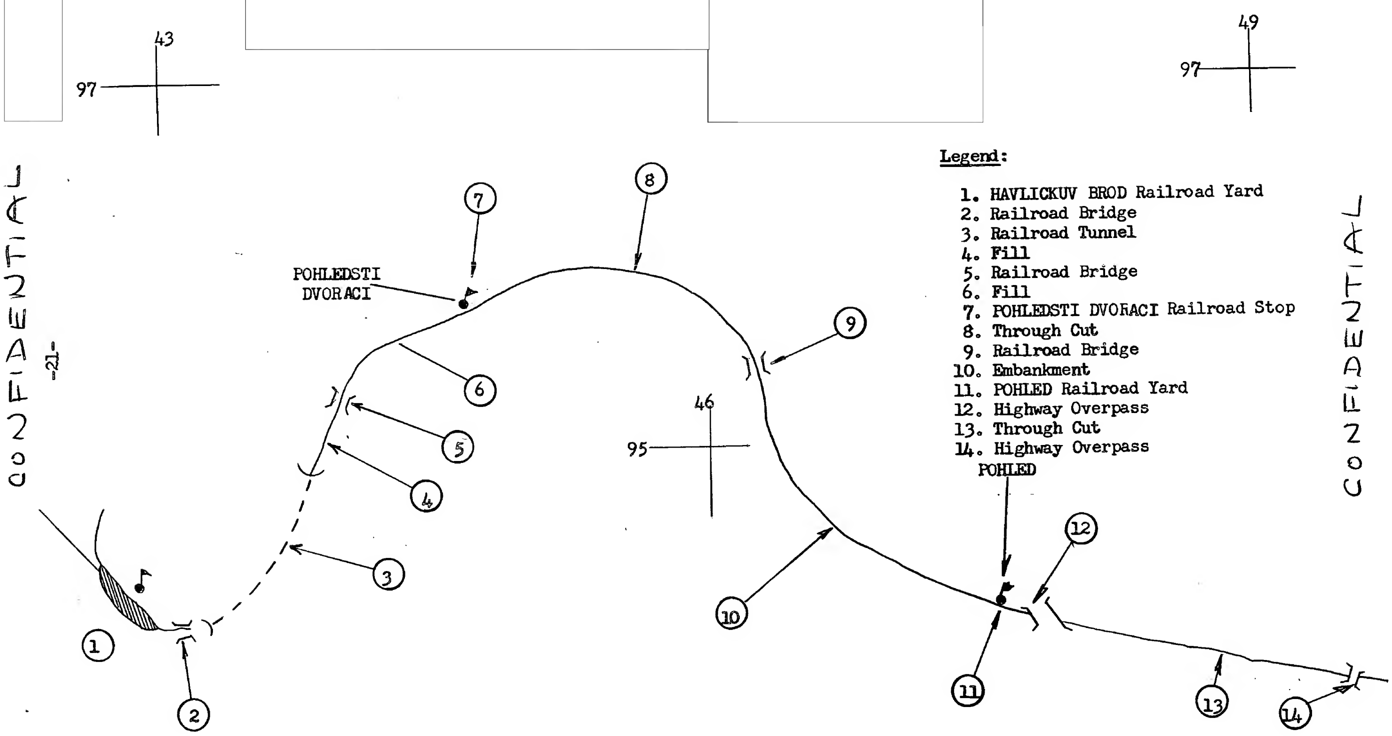
Annex E

OVERLAY OF ALIGNMENT OF AND INSTALLATIONS ON RAIL LINE HAVLICKUV BROD-NOVE DVORY, CZECHOSLOVAKIA



Legend:

1. HAVLICKUV BROD Railroad Yard
2. Railroad Bridge
3. Railroad Tunnel
4. Fill
5. Railroad Bridge
6. Fill
7. POHLEDSTI DVORACI Railroad Stop
8. Through Cut
9. Railroad Bridge
10. Embankment
11. POHLED Railroad Yard
12. Highway Overpass
13. Through Cut
14. Highway Overpass

Annex F

OVERLAY OF ALIGNMENT AND INSTALLATIONS ON RAIL LINE HAVLICKUV BROD-NOVE DVORY, CZECHOSLOVAKIA

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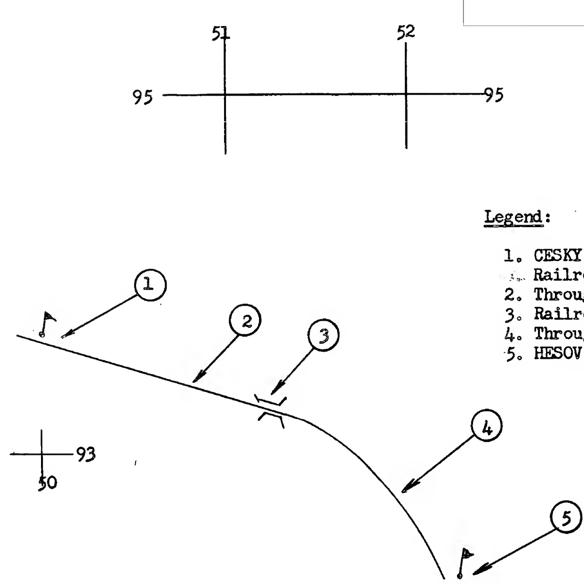

Legend:

1. CESKY SICNDORF (STRIBRNE HORY) Railroad Stop
2. Through Cut
3. Railroad Bridge
4. Through Cut
5. HESOV Railroad Stop

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Annex G

50X1-HUM

SKETCH OF HAVLICKUV BROD RAILROAD YARD IN CZECHOSLOVAKIA
(Not to scale)

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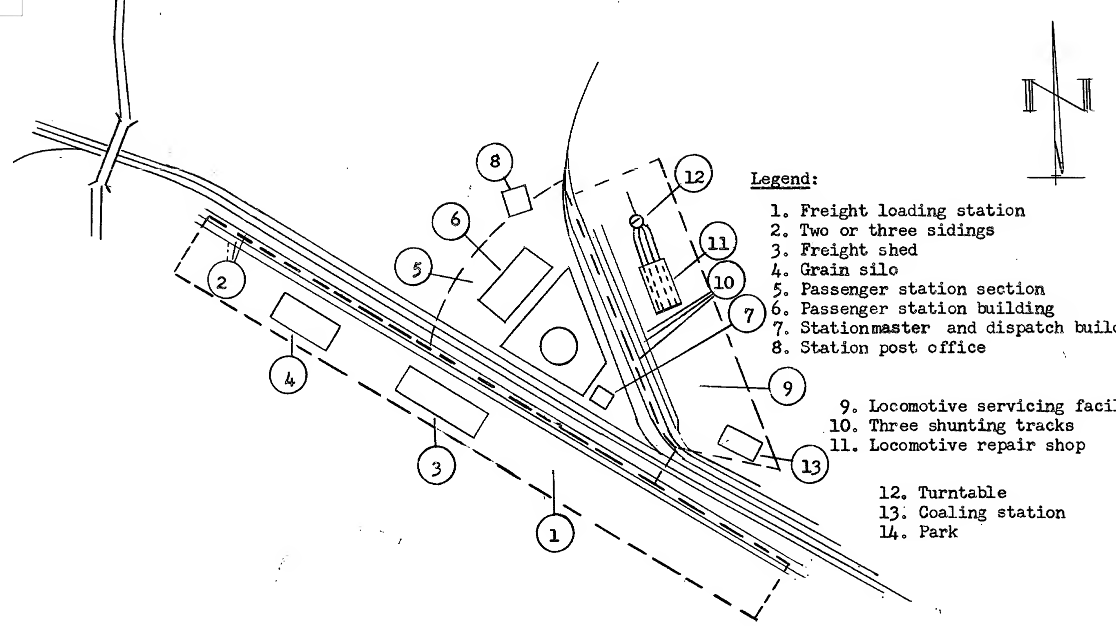

Legend:

1. Freight loading station
2. Two or three sidings
3. Freight shed
4. Grain silo
5. Passenger station section
6. Passenger station building
7. Stationmaster and dispatch building
8. Station post office
9. Locomotive servicing facilities
10. Three shunting tracks
11. Locomotive repair shop
12. Turntable
13. Coaling station
14. Park

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Annex H

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SKETCH OF TYPE OF BRIDGES ON RAIL SECTOR HAVLICKUV BROD -PRIBYSLAV-NOVE DVORY, CZECHOSLOVAKIA

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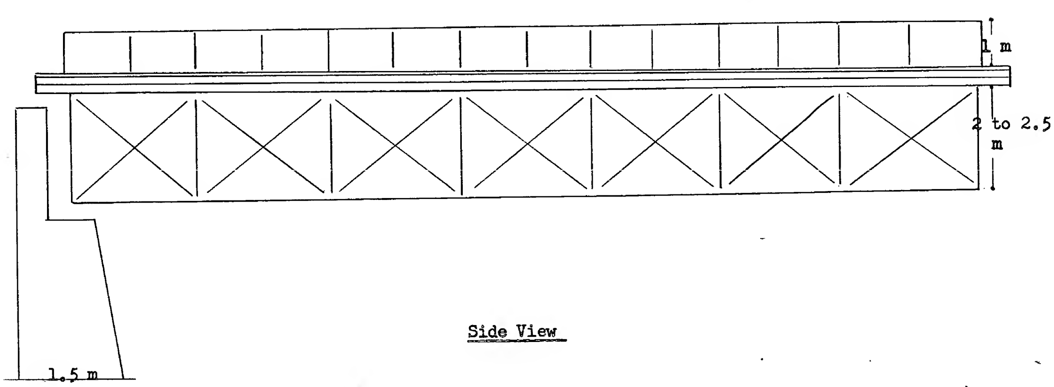

Side View

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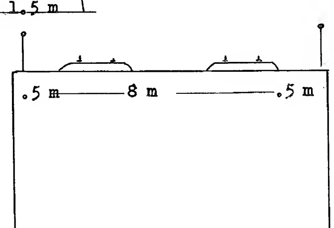

Cross-section View

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Annex I

SKETCH OF THE POHLED RAILROAD YARD IN CZECHOSLOVAKIA
(Not to scale)

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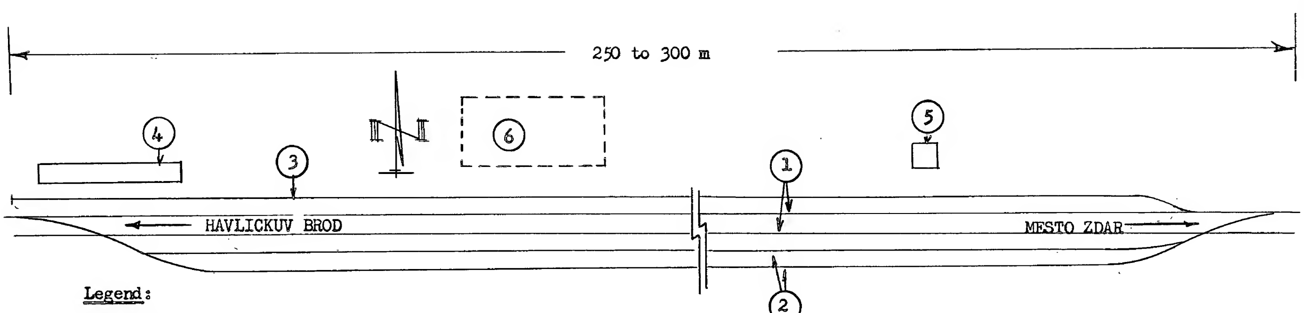

Legend:

1. Two main tracks
2. Two transient freight sidings
3. Local freight loading track
4. Warehouse, 45 x 9 x 4 m, brick, low gabled roof, with ramp extending to tracks.
5. Stationmaster (temporary building)
6. New station building construction site

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OVERLAY OF ALIGNMENT AND INSTALLATIONS ON RAIL LINE HAVLICKUV BROD-NOVE DVORY, CZECHOSLOVAKIA

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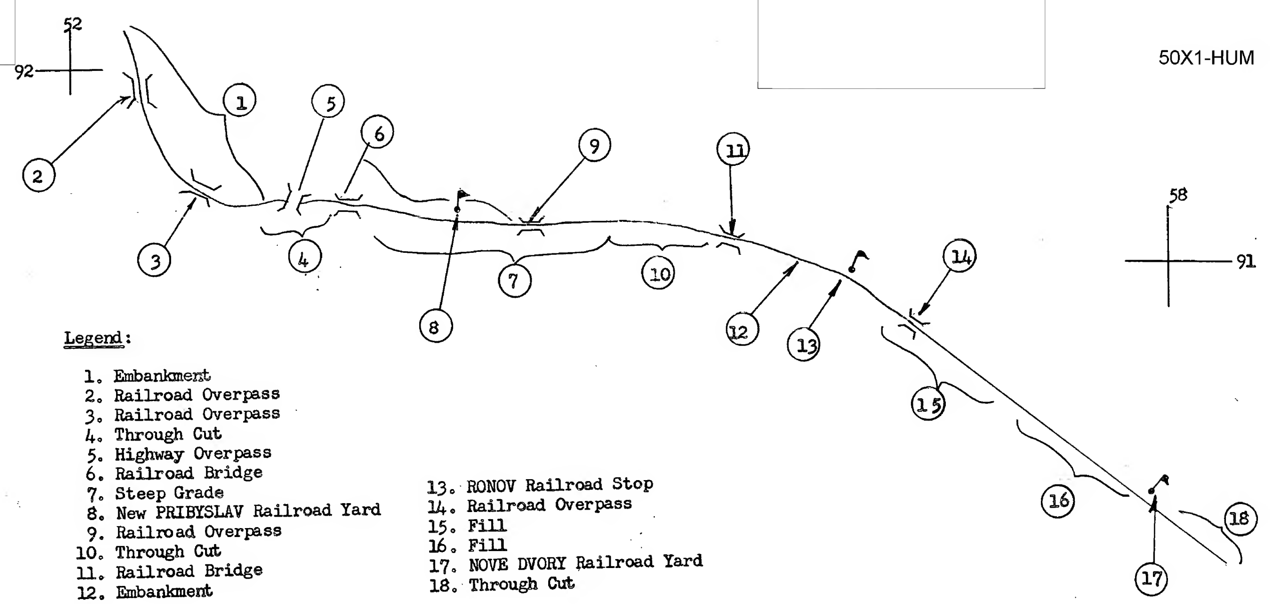

Legend:

1. Embankment
2. Railroad Overpass
3. Railroad Overpass
4. Through Cut
5. Highway Overpass
6. Railroad Bridge
7. Steep Grade
8. New PRIBYSLAV Railroad Yard
9. Railroad Overpass
10. Through Cut
11. Railroad Bridge
12. Embankment
13. RONOV Railroad Stop
14. Railroad Overpass
15. Fill
16. Fill
17. NOVE DVORY Railroad Yard
18. Through Cut

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Annex K

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SKETCH OF THE PRIBYSLAV, CZECHOSLOVAKIA, RAILROAD YARD

(Not to scale)

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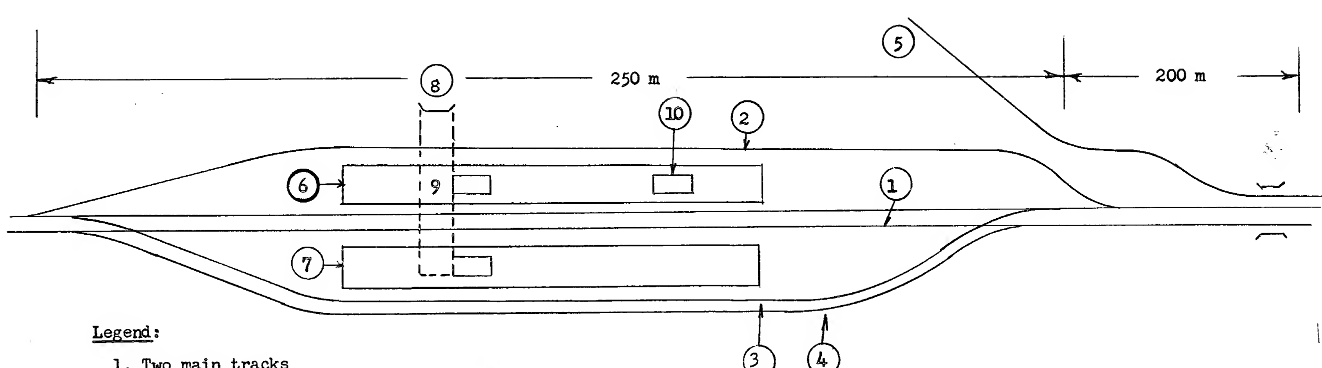

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Legend:

1. Two main tracks
2. Siding for transient freight traffic
3. Siding for shunting freight and passenger cars
4. Siding for shunting freight cars
5. Main track of old line
6 and 7. Passenger platforms
8. Entrance to underpass
9. Underpass
10. Shed, temporary stationmaster office

Annex L

OVERLAY OF APPROXIMATE LOCATION OF RAILROAD BRIDGE IN CZECHOSLOVAKIA

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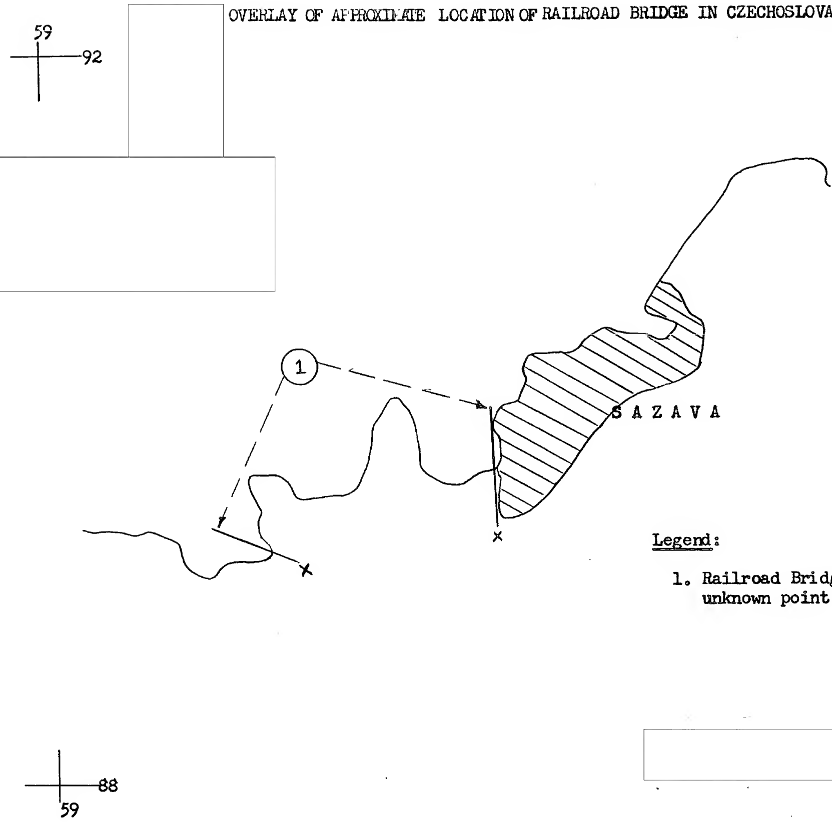

Legend:

1. Railroad Bridge located at unknown point between x's.

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Annex M

PINPOINT LOCATION OF TWO CZECHOSLOVAK HIGHWAYS

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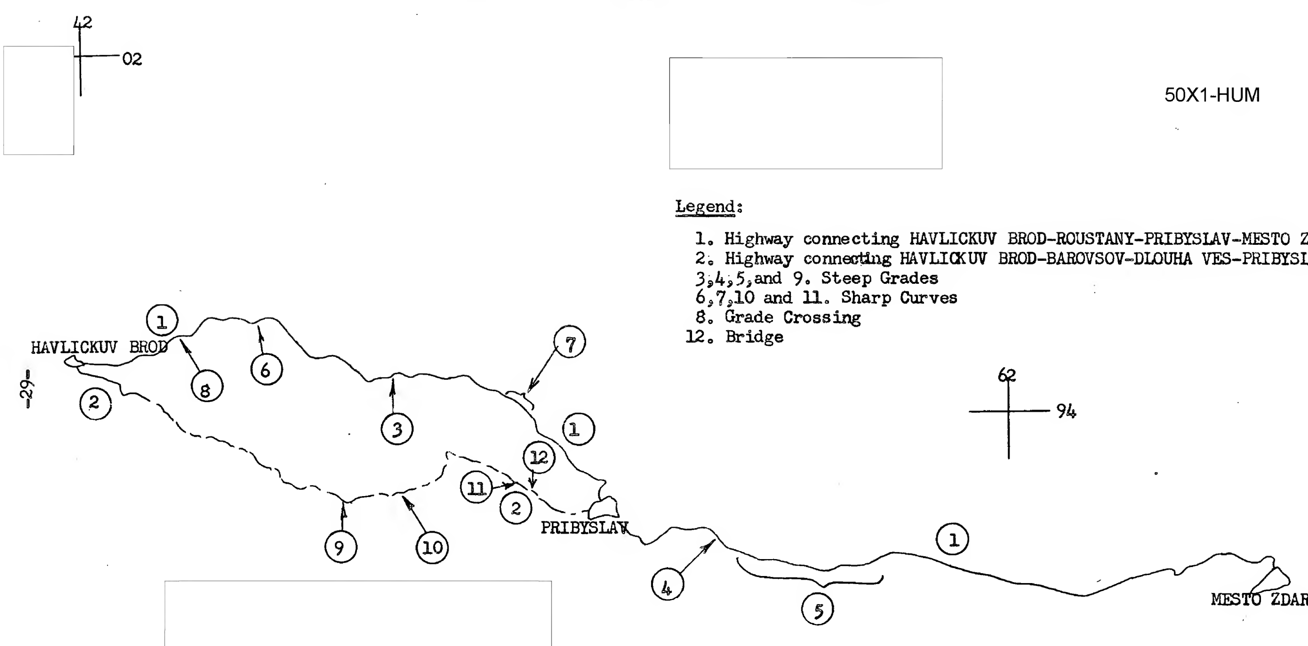

Legend:

1. Highway connecting HAVLICKUV BROD-ROUSTANY-PRIBYSLAV-MESTO ZDAR
2. Highway connecting HAVLICKUV BROD-BAROVSOV-DLOUHA VES-PRIBYSLAV

3,4,5,and 9. Steep Grades

6,7,10 and 11. Sharp Curves

8. Grade Crossing

12. Bridge

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Annex N

ELECTRIFICATION OF THE CZECHOSLOVAK RAILROADS

Professor (Dr Ing) Frantisek JANSA
University of Railroad Engineering, PRAGUE

The text below is a summary of a highly successful lecture which Dr JANSA, during his visit to BUDAPEST, gave at the Hungarian Electrotechnical Association's meeting on May 15, 1956. Dr JANSA is familiar with all aspects of the electrification of Czechoslovakia's railroads. As one of the leading personalities in the Czech electrical industry, as railroad electrification plans director, and as a professor at PRAGUE's University of Railroad Engineering, he participated in all the phases of the electrification program.

In the first Five-Year-Plan the Czechoslovak State Railroads started, according to plan, the electrification of various important rail lines. During the two years preceding the first Five-Year-Plan (1946-1947), studies were completed to define the engineering and economic requirements, so that the Five-Year-Plan could embrace actual planning for electrification of Czech and Slovak rail sectors. Electrification planning progressed so rapidly that in 1953 it was possible to begin the first preliminary test operations with a new-type locomotive on a section of track which was equipped with a new type of overhead contact wire powered by a new rectifier sub-station. After a transition period of several years, during which only certain rail sections were partially electrified, electrically powered transportation was started on all Slovak rail sections which had been earmarked for electrification.

The following is a resume of the solutions to various technical problems, of the experiences gained from operation, and of developments proposed for the future. In comparison with other countries, Czechoslovakia lagged far behind in railroad electrification. Before WW I only a few feeder lines had been converted to electricity. Electrical operation is still being conducted on those lines. The 1928 electrification of the main railroads was limited to the PRAGUE junction and the lines to its suburban railroad stations. In this instance a total of 70 km of rail line (120 km of track) was converted to 1,500 V DC. Between 1930 and 1935, the period of economic crisis, extensive modernization was carried out in the railroad transportation.

The primary purpose of this modernization was to make less wasteful the completely uneconomical steam operation on local and feeder lines; this, however, did not increase the capacity of the main lines, nor did it solve the fuel supply problem of heavy trains. It was estimated that, by electrifying only about 1,500 km of the businest main lines, an annual saving of 2 million tons of coal could be realized. Also at that time, 50 percent of the railroads' coal consumption occurred on these 1,500 km of railroad line, whereas under the proposed plan, electric operations would have required only 12 percent of the coal needed for the entire railroad network. At the present time, 5,000 km of rail line have been electrified.

After 1945 the railroads' primary mission was the resumption of operations and the renovation of railroad installations and rolling stock damaged in the war. A second task was the fastest possible increase in the volume of East-West traffic. This was necessitated by expanding industrial growth, the increase in economic activity, and the increase in the exchange of goods between the Soviet Union and the people's democracies.

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In Slovakia a serious bottleneck developed on the KASSA (KOSICE)-BOHUMIN line, on which, particularly on the steep grades at the foot of the Tatra Mountains, even the construction of a second track did not make it possible for steam to handle normal traffic for extended periods of time. The Slovak authorities were the first to initiate steps toward electrification of the 165 km stretch between ZSOLNA and IGLO, which had grades in both directions. On June 4, 1946, they issued to industry contracts for designing the electrical equipment.

The line from PRAGUE eastward to CESKA TREBOVA was selected as the second line to be electrified. This line had already reached its capacity under steam operation. It was expected that both the traffic capacity and the speed would increase significantly with electrification. After exhaustive study, the Czechoslovak State Railroads decided on 3,000 V DC for the motive power. The railroad received the direct current through rectifiers from the national power net. The following factors had a decisive influence on the selection of this system:

1. Rail lines with the greatest volume of traffic had to be electrified in the shortest time possible, without interfering with traffic and without necessitating long drawn-out tests of various new and/or already existing types of equipment.

2. It was necessary to select a proved system, one which on other railroads and under similar conditions had proved successful.

3. After WW II the Soviet Union, Poland [redacted] persisted in further expansions of their 3,000 V DC systems; similarly, [redacted] also adhered to the DC system.

4. The power supply system had to be such that the 50-cycle high-tension 3-phase power from the national net could be used without additional expense for the establishment of the railroad's own power plants.

5. It was necessary to adopt a system which would make possible the economical utilization of highly effective motor-coaches. To a great extent, train units consisting of motor-coaches had to be introduced into all suburban and long distance rail operations.

6. It was necessary that trains be able to change in PRAGUE to the 1,500 V DC lines.

Because of these considerations, the 3,000 V DC system was the most suitable. The low-cycle one-phase system had to be discarded because of the expense of establishing the power plants and the high-tension power network, and the construction expenses of a flexible network's transformers. On the other hand, careful consideration was given to the suitability of the 50-cycle one-phase system. Finally, its suitability was put aside and it was considered only as a developmental problem, since facts known at this time were not sufficient to allow conclusions regarding reduction of costs or reliability of operation, particularly in regard to the heavy and dense traffic on the lines to be electrified.

The electrification plans were worked out by the engineering industry's Railroad Planning Institute, which was especially established for this purpose, and which in May 1948 handed the plans over to the railroad directorate. The study embraced essentially the following: power transfer plans for the 100,000 V to 3,000 V supply; detailed plans for an overhead trolley wire system constructed of standard items capable of withstanding speeds up to 150 km per hour; plans for 3,000 V rectifier sub-stations with a 2-hour rating of 2x-, 3x- or 4 x 3,600 KW; and plans for 3,000 V electric locomotives with an hourly rating of 2,400 KW.

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On the basis of this study, which also summarized construction material requirements and costs, the government decided on the main lines to be electrified and incorporated into the first Five-Year-Plan as the ZSOLNA-IGLO (165 km) and the PRAGUE-CESKA TREBOVA (164 km) lines. The state railroads then issued contracts for the rectifier sub-stations to CKD, STALINGRAD, for the locomotives to the Lenin Works (Skoda) PILSEN, and for the construction of the overhead trolley wires to EZ, PRAGUE. The Ministry of Energy ordered the construction of the 100,000 V high-tension distribution net, the transformer stations, and related switching stations.

Various Construction Details

Power Supply: As already mentioned, the electrified lines are fed from the national power net, which is a 110,000 V industrial net with a superimposed 220,000 V net. One x 3-phase 100,000 V lines were constructed along the entire rail line. The line's transformer and switching stations served to supply the railroad's rectifier sub-stations as well as the 22,000 V public utilities net. The primary side of the rectifier transformer is wound for 22,000 V and is connected at the transformer station with its own 100,000/22,000 V regulating transformer. In case of breakdown, or because of other circumstances, it is possible to supply the rectifier sub-station from the net transformer (Diagram 1). On the primary side of the regulating transformer are 100,000 V 8 x 2 percent taps which may be switched in when under a load; thus, the rectifier sub-stations can operate with constant voltage on the high-tension side. The switch-over can be controlled automatically or manually. As rectifiers the transformers have a total capacity of 10 mega-volt-amps. The transformers' short circuit voltage is 8 percent. The 110,000 V circuit breakers on the primary side have a capacity of 2,500 mega-volt-amps.

Rectifier Stations: The locations and built-in capacities of the rectifier sub-stations were selected on the basis of operational and economic calculations and considerations. The distance between sub-stations along the entire rail line is uniformly about 20 km, which, with a total overhead trolley wire cross-section of 270 sq mm of copper, makes possible the movement of 7,600 to 13,200 tons per normal hour. In the event of one-sided power feed or a power supply failure, assuming identical voltage drops, the movement capacity drops to 2,000 to 3,400 tons per hour. The smaller numbers designate heavy freight trains (1 train per power distribution section), while the larger numbers designate light passenger trains or trains consisting of motor-coaches (10 trains per power distribution section). This can be seen readily on Diagram 2, which shows the relationship between power supply station interval and hourly movement capacity.

Diagram 3 is a sketch of the hook-up of the rectifier sub-stations and the overhead trolley lines. The two tracks are fed from two sides, independently of each other. Each rectifier sub-station usually consists of three rectifier units, two in use and one in reserve. Each rectifier unit consists of an oil transformer and two groups (2 x 6) of single-anode, air-cooled rectifiers with steel tanks. The 3-phase, full-wave bridge rectifier used furnishes 12-wave direct current. The continuous output of one unit is 2,400 kw (730 amps @ 3,300 V); the two hour overload capacity is 50 percent and the 5-minute capacity is 200 percent.

The single-anode plates operate with continual pumping and with continual auxiliary arcing. The anode leads and the cathode plates are insulated and sealed with lacquer. Similarly, carbon binding and control grids are used on the carbon anodes. Control grids are used for automatic voltage reduction to compensate for differences in load between sub-stations (Diagram 4).

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Transducers are used to measure the direct current and the direct voltage. Polarized, high-speed circuit breakers protect the rectifiers against back current in case of flashback from the direct current side; further, the transformers are equipped with cut-out relays on the high-tension side. The relays contain quick-operating anti-short circuit elements, which operate within a half period.

Similarly, high-speed circuit breakers protect the outgoing power lines; these, however, are not polarized and thus kick out in the event of a surge of current in either direction. As a rule, seven high-speed circuit breakers are installed, six of which are operational, with one for a reserve.

Overhead Trolley Wires: In view of the various operating speeds encountered on station and open tracks, primarily chain-suspended overhead support wires with tensional trolley wires were constructed. The standard types of overhead support wires are the following (Diagram 5):

1. Seldom-used station tracks, with speeds to 30 km per hour: simple overhead support wire system with 80 to 100 sq mm copper tensional trolley wires.

2. Sidings and feeder tracks, with speeds to 60 km per hour: chain-suspended overhead support wire system with stabilized messenger cables and 120 sq mm copper tensional trolley wires (Diagram 5a).

3. Open lines and curved sections, with speeds to 90 km per hour: chain-suspended overhead support wires with 120 sq mm copper tensional messenger cables and with 150 sq mm copper tensional trolley wires (Diagram 5b).

4. Open lines and main through-station tracks, with speeds to 150 km per hour: chain-suspended overhead support system with 120 sq mm copper tensional messenger cables, with auxiliary support wires on the posts, and with 150 sq mm copper tensional trolley wire (Diagram 5c).

5. Other Data:

Distance between posts: 60 m.

Tensile Strength: 1,500 kg (150 sq mm copper trolley wire),
1,440 kg (120 sq mm copper trolley wire).

Maximum temperature variation: 60° C (-20°C to $+40^\circ$C)

Interval between weights that maintained tension on the overhead trolly wires: 1,200 m.

Trolley wire alignment: Normally 30 cm; allowed deviation 15 cm; maximum allowable deviation from track center line 45 cm.

Wind pressure: 75 kg/sq m of cylindrical cross-section.

Stress on structural steel: 15 kg/sq mm at a tensile strength of 38 to 42 kg/sq mm.

Reinforced points:

On open lines: welded steel pillars mounted on concrete bases along both sides of track. Tension towers; welded lattice columns, reinforced with bolts imbedded in concrete foundations.

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Sub-stations: Cross-wire bracing with a tension interval of 30 to 140 m, and a wire sag of 1/7.

Along open stretches the overhead trolley wires are attached to swivel support arms. In stations, two transfer wires are employed in addition to the usual cross-wire suspension.

Insulators: Regular single-capped insulators, stressed only for tension (Diagram 6). Rod insulators with screw fasteners stressed for tension, bending and compression (6,000 kg tension, 3,500 to 4,000 cm-kg bending moment (Diagram 7). Under dry and clean conditions, the arc-over voltage is 75,000 V; when dirty and wet, the minimum arc-over voltage is 25,000 V.

Diagrams 8, 9, and 10 show a few sections of the finished overhead trolley line.

Electric Locomotives

In the initial plan the planners took under consideration the 1 Do1 axle express train arrangement locomotive, with a top speed of 130 km per hour and the B'oB'o arrangement passenger and freight locomotive, with a top speed of 90 km per hour. After the decision to electrify the main rail lines, the following locomotive performance requirements were established:

Long-distance express trains: train weight 240 tons, maximum speed 120 km per hour.

Express trains: train weight 720 tons, maximum speed 120 km per hour.

Passenger trains: train weight 480 tons, maximum speed 90 km per hour.

Freight trains: train weight 1,440 tons, maximum speed 60-90 km per hour.

Besides this, the railroads required a transition from 3,000 V to 1,500 V on the electrified Prague line. The maximum axle pressure was established at 20 tons. The maximum gradient was 15 ‰ (1.5 percent).

The four-axle, swivel-truck locomotive with standard mechanical components but with two different types of motors is well suited for these requirements. The contemplated long-distance and express locomotives differed from the passenger and freight locomotives only in their motors and gear train; the structural component and electrical installation would have remained uniform. Through an exhaustive study of the reduction of the field of series-connected DC motors and the subsequent drop in rpm, and by selection of a slightly lower rpm for the one-hour rating, success was achieved in constructing a unit locomotive which meets all requirements. This also necessitated taking into account the motors' somewhat larger lead. In operation, however, the gains were so advantageous that they far surpassed the additional expense involved in developing the unit locomotive. This prompted the decision to develop only one locomotive type for line service, the so-called unit locomotive, with four-axle drive and a pressure of 20 tons per axle, that would meet all specifications concerning train weights and maximum speeds. At full field, the indicated speed had to be less than 60 km per hour. The motor was rated at the tractive effort required to move 720 tons up a 15 percent grade. Thus, the drive motor was rated at 600 kw/hr at 58 km per hour. On a level stretch the 120 km per hour maximum speed with a 720-ton train necessitated a very large field reduction. This field reduction still permitted the motors to develop their

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full power at 120 km per hour. Bearing in mind the high speeds required of express and international trains, the goal was to design the smallest possible unsprung unit. The drive motors are attached to the trucks. The driving force is transmitted to both ends of the driven axles through drive shafts and simple gears, which, with the flat steel leaf springs connecting axle pair ends, form a quadrangular (Oerlikon system).

Figure 11 gives dimensions and general layout of the E499 series electric locomotive. The general data on the locomotive are the following:

Axle system	B_0^0 B_0^0
Contact wire voltage	3,000 V DC
Gear ratio	1:2.27
Service weight	80 tons
Maximum speed	120 km per hour
Hourly capacity	2,400 kw
Hourly speed (full field)	58.6 km per hour
Sustained capacity	1,920 kw
Sustained speed	65 km per hour
Hourly tractive force	14,700 kg
Maximum starting tractive force	24,000 - 32,000 kg

The mechanical parts of the locomotive are in keeping with the latest advances in electric locomotive construction. The locomotive body is spring-attached to the two double-axle trucks. A pivot connects the body to the trucks' upper cross braces. This arrangement places the pivot as low as possible, which reduces axle pressure displacement and the tilting movement transmitted through the couplings. The buffers and couplings are mounted to the locomotive frame.

Because axle pressure limited the weight to 80 tons and because of the relatively great power inherent in the locomotive, simplicity of construction and mechanical soundness posed design problems. Locomotive body and wheel truck bearing frames are of welded steel stampings.

A feature of this construction is the perfectly vertically aligned radial bearing, which has no side play. This prevents excessive wear of the axle-connecting leaf springs through lateral play.

The two trucks are flexibly connected to each other in a horizontal plane. This cuts down on "wandering" and eases entry into curves. In operation it was definitely established that the locomotive rode with complete ease at all speeds and on all track sections. The electrical equipment, with the exception of the drive motors, is located within the locomotive body. The air pressure-operated collector bows (pantographs) are situated on the roof, approximately in the vertical axis of the king pins. The external ventilation rheostats are located along the inside roof of the locomotive, between the two pantographs. Metal sheeting separates the rheostats from the motor compartment. A control cab is located at each end of the locomotive, and can be entered from one side only (from the left side, facing forward). Between the two control cabs is the motor compartment, which can be entered from either of the two control cabs. Within the motor compartment are

the entire auxiliary motor aggregate and the electric switches, such as two ventilator motor units with two electric air compressors, air-pressure actuated electric switches, two electric-pneumatic reversers, and the main high-speed circuit breaker. The ventilator motors are wound for 1,500 volts (half line voltage) and are permanently connected in series. These motors power one ventilator for each two drive motors and also drive one 48 V auxiliary generator. At the time of starting, when the resistors are switched on, a portion of the forced ventilation is automatically directed to the rheostats. The air compressor motors are wound for the full 3,000 volts and are connected in series with additional switch resistors for a 10 percent voltage drop.

Shunt resistors with six taps each and iron-core choke coils serve for field reductions. From an economy standpoint, the magnetic field of the motors can be reduced to 44 percent.

The indirect electro-pneumatic control is a newly developed product of the Lenin (Skoda) Works of PILSEN. Its advantage is the central plate cam switching gear, which is operated by electrically regulated compressed air. There are 23 resistance and 5 economic field reduction settings in the series-connected drive motors. With the latter it is possible to operate between the speeds of 25 and 58 km per hour. Each pair of parallel-connected drive motors has 7 resistance and 7 field reduction settings,giving speeds ranging from 55 to 120 km per hour. In practice, therefore, it is possible to operate economically at all speeds between 25 and 120 km per hour without additional switch resistance.

Each control cab is equipped with a safety system, which lights up a warning light every 90 seconds. Within 6 seconds after the light goes on, the engineer must extinguish the light by pressing a button. If, after the light has been on for 10 consecutive seconds, the engineer still does not extinguish it, a horn blows to remind him. If after all this the light is still not turned off, the main switch is automatically disconnected and the emergency brake is tripped. Warning light response buttons are placed in three locations: one is a foot switch near the engineer's right foot; another is a button on the control panel, which the engineer can reach with his right hand by leaning slightly forward; and the third is also a button on the left side of the cab, used when the engineer is leaning out the cab window, for example, during switching operations.

Motor temperatures, specifically, temperatures of the commutating pole, are constantly recorded by a cross-coil instrument, enabling the engineer to check the temperature at all times. A colored scale makes temperature limits readily apparent and also warns of overheating.

Because the locomotives will also have to pull heavy freights on mountain grades, the designers strove for the most effective utilization of the locomotive's adhesive weight. As is known, the differences between drawbar pull at the plane of the axle pivot and the pull through the couplings create a tilting movement, which in turn causes varying increases and decreases in axle pressures. In individual drive, and especially in the event of series-connected motors, these differences make it seem that the adhesive weight had decreased. The tilting movement is equalized mechanically at the trucks, raising the utilization of the adhesive weight to a theoretical 92 percent. This equalization is performed by air cylinders situated between the locomotive body and the wheel trucks. With pressures equal to the drawbar pull, these cylinders halt axle pressure displacement. The pressure in the equalizing air cylinder varies to conform with the drawbar pull, and is automatically controlled through the motor current by a pressure regulator. In this manner, the difference in pressures between the two axles of a single truck is completely equalized. As a result, the tilting movement transmitted through the

couplings represents a maximum of 8 percent axle pressure displacement at the leading truck. Equalization of this would not be economical, since it would necessitate undesirable modifications in the electric system. In spite of this, adhesive values of 30 percent have been recorded with this locomotive and, employing sanding, readings over 40 percent of more than several seconds duration have been attained.

The completed prototype locomotive was within 60 kg of the prescribed weight. On the basis of heating tests, the sustained capacity was raised to 2,000 kw, which made for maximum utilization of the allowable coil heat. Figure 12 is a photo of the locomotive. Figure 13 is a load diagram computed from actual performance tests. Solid lines indicate express trains; dash lines indicate heavy freights composed of 2-axle cars. The locomotive in operation proved itself capable of steady speeds, gradual acceleration, good current pick-up, maintenance of the tighter time schedules prescribed.

Since actual operational service testing of the locomotive would have had to be postponed because of rail line repair work and modifications to and repair of signal systems, it was decided to hold operational trials outside the country. The Polish National Railroads very considerately took on the months-long project of testing the locomotive. It was thus that the first and second locomotives have operated for 200,000 km of trouble-free service in WARSAW's suburban rail net. The locomotives were then disassembled at the factory in order to examine them more critically for aging and wear, so that embarrassment and work stoppages during serial production could be eliminated.

Observation During Operation

Before being placed in service, the locomotive's electric system was subjected (to the maximum extent possible) to tests designed to check its capacity and safety, as well as to determine the effects of overloading. These tests were also conducted during later road testing. The tests resulted in several valuable observations:

a. At rectifier sub-stations the short circuit cut-out selectivity was so staggered that shorts in the overhead wire were disconnected only by the line high-speed circuit breakers; more specifically, only the circuit breakers on the affected rail sector would go into operation. The selective circuit breakers operated without a hitch during arc backs and overloads on the high tension side as well as on the direct current side.

b. The air-cooled rectifiers are ready for operation immediately, and after a few minutes operation are for a short time capable of being overloaded.

c. In certain instances tension oscillations occurred in high-speed circuit breakers when cutting out the overhead power lines, which in turn created arc backs in the circuit breakers. It was necessary to dampen the oscillations. Upper (fifth) harmonics seeped from the high-tension lines into the railroad power network, so that the effective value of the upper harmonics was higher than was required for the 12-wave direct current. The upper harmonics came from the electric power station, which was supplied by the same high-tension lines.

d. In operation, the overhead wires performed outstandingly. After the cleaning of the overhead power lines, the current pick-up was practically sparkless throughout the range from maximum starting current (approximately 1,200 amp) to maximum speed (600 amp, 120 km per hour). The independent supply of current to the two sets of tracks proved effective. The direct grounding of the lattice towers and other equipment along the tracks was largely responsible for reducing

the resistance of the rails, so that a significant portion of the current could flow back into the ground. Recognition of this led to active measures in reducing the corrosion of telecommunications cables. The design as well as the construction of the power station's large cross-arm suspension towers proved rather difficult. Track modifications at stations are inconvenient and the reconstruction of overhead lines is expensive.

e. The hauling capacity of the locomotives is 30 percent greater than specified, since the coefficient of adhesion is greater than that commonly effected for similar locomotives. Energy consumption is 25 percent lower; i.e. 12 to 14 watt hours per ton kilometer in through freight traffic, and 17 to 20 watt hours per ton kilometer in passenger service in mountain areas where ascents do not exceed 15⁰/oo (1.5 percent).

f. The hauling capacity can be further increased by making the locomotive 15 percent heavier, not including the weight of the motors. Tests of motor winding temperatures were successful and made it possible to make up considerably longer trains for mountain runs than were deemed feasible. Overvoltages in the locomotives had to be reduced in order to eliminate sparking and switching arc backs. The 3,000 and 1,500 volt motors of the air compressors and blowers operated satisfactorily.

g. The scheduled running time of heavy freights was cut from 5 to $3\frac{1}{2}$ hours, still maintaining a reserve for layovers and late arrivals, so that maximum speed did not exceed that of steam operation.

h. With the increase in train weights it seems necessary to develop more powerful locomotives, although in practice this depends upon the tensile strength of the couplings. Since we could probably expect to get 35,000 kg drawbar pull even with an adhesive weight of 92 tons, it follows that coupling with a tensile strength of 105 tons has a safety factor of only 3.

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Figure 1

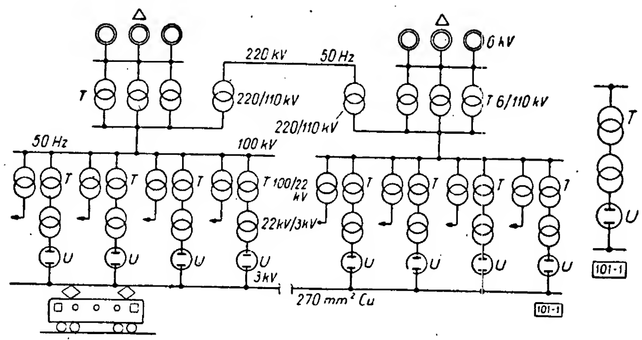
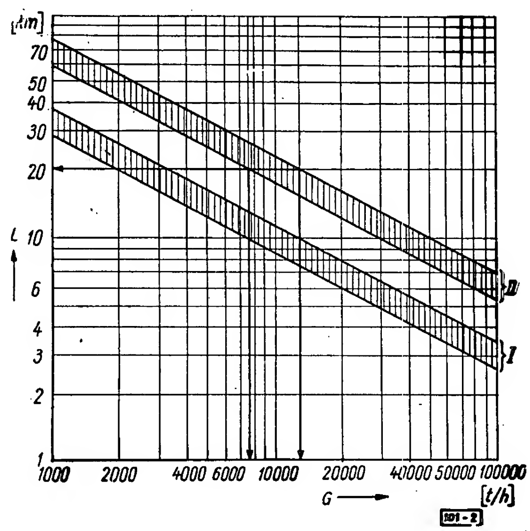


Diagram of the Contact Wire

Power Supply

Figure 2



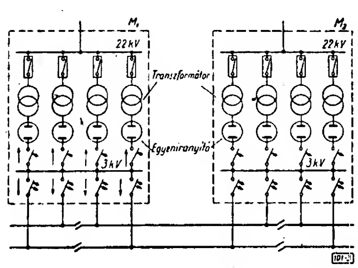
L--Interval of Feed Points;

G--Hourly Movement Capacity

II--Bilateral Feeding

I--Unilateral Feeding

Figure 3



Simplified Wiring Diagram of the Rectifier

and Contact Wire

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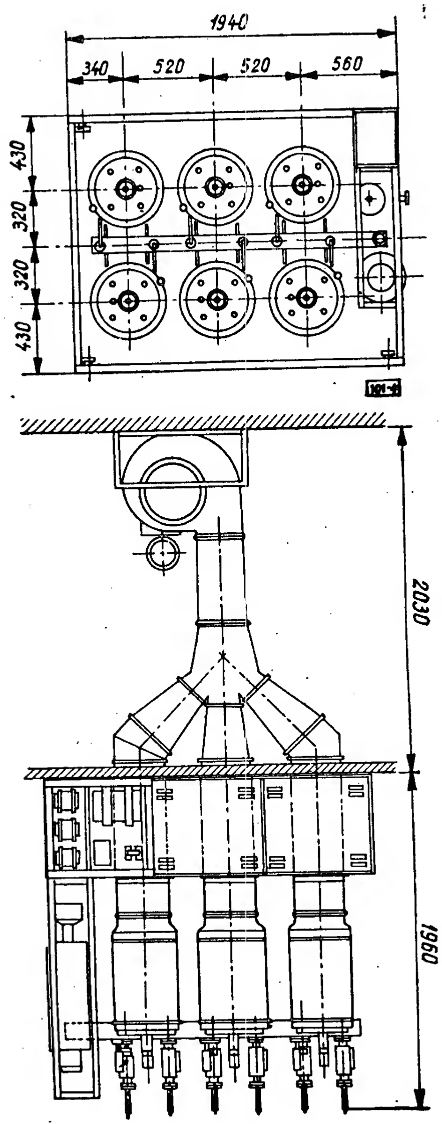
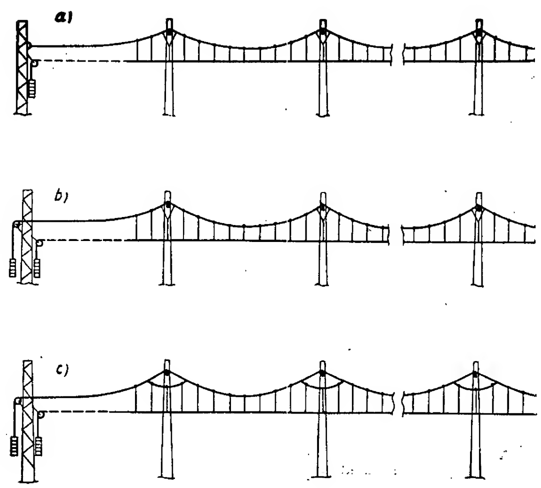
Figure 4



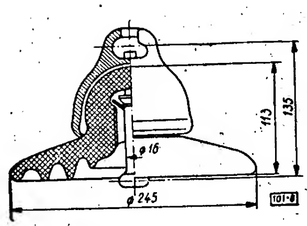
Rectifier Group

Figure 5



Types of Contact Wires

Figure 6



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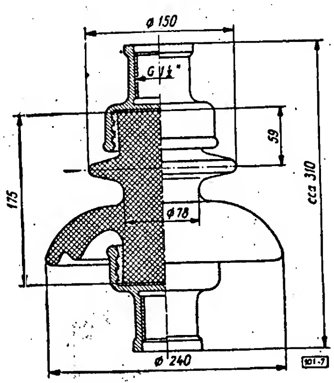
Single-Cap Insulator

Figure 7



Rod Insulator

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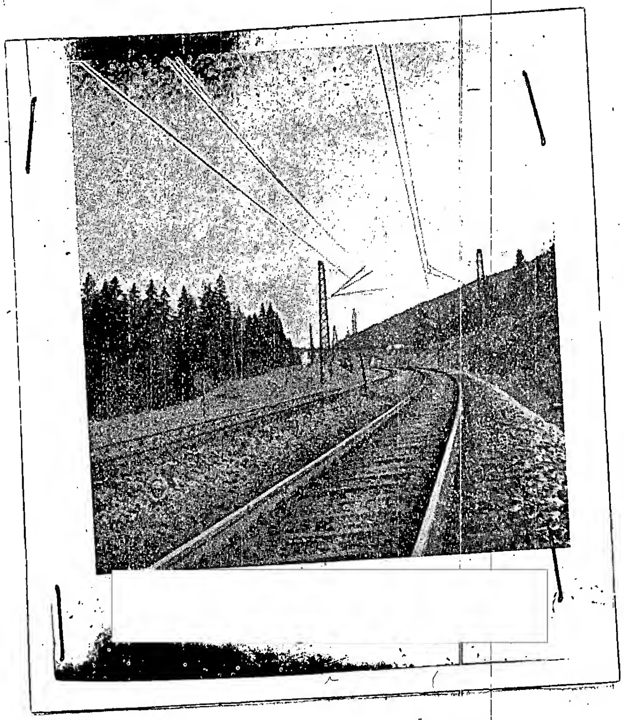

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Figure 8 - Contact Wire on Curve of Railway

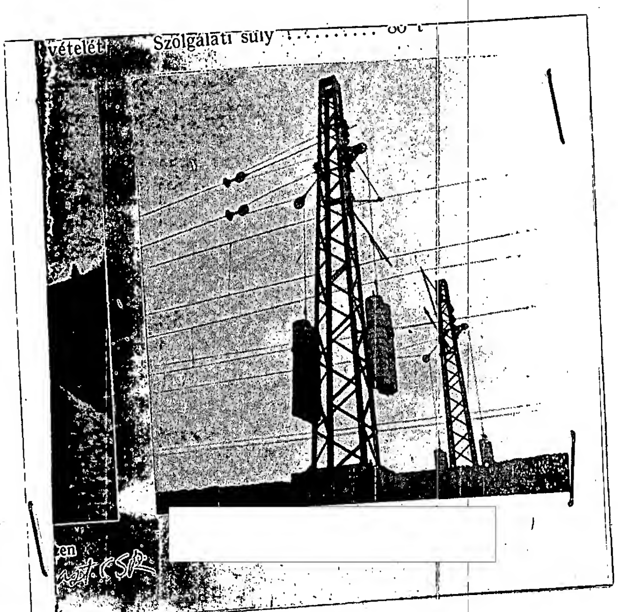

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Figure 9 - Contact Wire Stretchers

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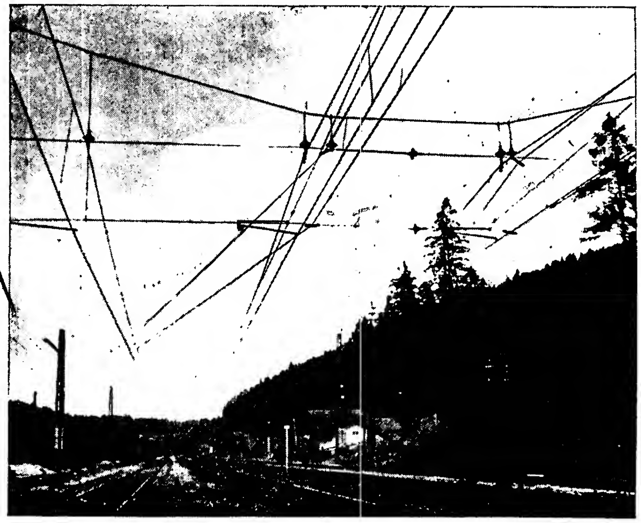
Figure 10



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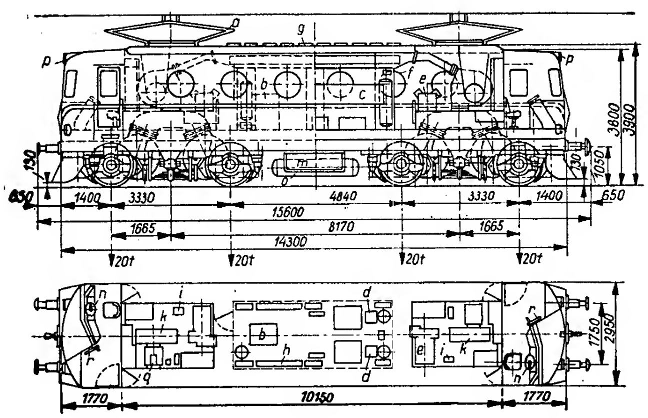
Overhead Trolley Lines on a Station

Figure 11



Model E499 Electric Engine Unit. 2400kw, 3000V DC, 120km/h

a. Trolley Contact
b. High-Speed Circuit Breaker
c. Switching Gear
d. Series Resistors
e. Air Compressor
f. Compressed Air Connection
g. Rheostats
h. High Tension Fuses and Protective Switches
i. Direction Changer
k. Ventilators of Motors and Rheostats
l. Driving Motor
m. Battery
n. Control Switch
o. Control Reservoir
p. Air Cooler Intake Duct
q. Searchlight
r. Auxiliary Dynamo
s. Hand Brake Wheel

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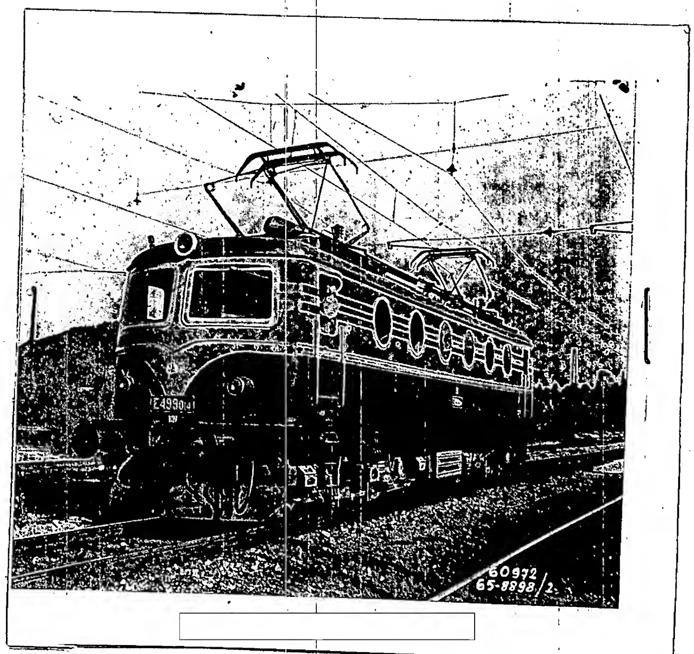
Figure 12



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Model E499 $B_0' \, B_0'$ Electric Engine

Figure 13

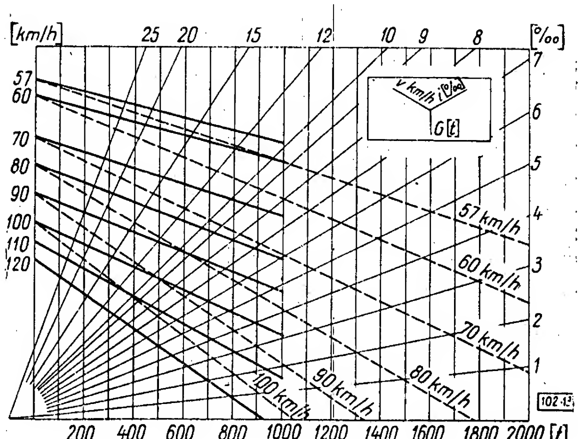

Diagram of the Working Capacity of the Electric Engine

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